Information Management and Technology

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Introduction

"It's not something we can see, really. We certainly can't touch, taste, hear, or smell it. Yet it's always there when we look for it, available wherever we bother to direct our attention. We can glean it from the pages of a book or the morning newspaper and from the glowing phosphorous of a video screen. Scientists find it stored in our genes and in the lush complexity of the rain forest. The Vatican library has a bunch of it and so does a performer's latest CD. And it's always in the air when people come together, whether to work, play, or just gab. What is it that can be so pervasive and yet so mysterious? Information."

Information came into its own when engineers at Bell Laboratories came up with a measure of information based on the mathematics of probability. This led to designs for anti-aircraft guns, which in turn began laying the foundation for cybernetics, the study of how information can control machines. Since that time many uses for information-carrying signals have been developed. For years the spectacular proliferation of digital computing technology has been changing the rules of business and information. This digital tide has already reshaped the business world and is now spilling out of the office to touch every aspect of American life. Driving the change in business is the computer's ability to reduce all conventional information forms into one big resources pool. The purpose of this chapter will be to examine the kinds of business information needed to properly manage facilities. Four aspects of information management will be discussed:

1. Information needed to manage facilities and infrastructure
2. Determining and implementing the kinds of information, applications, and processes that could be computerized
3. Impact of the information revolution (technology) on business functions in the future
4. APPANet: its World Wide Web home page

Information Needed to Manage Facilities and Infrastructure

Describing the information that is needed to manage facilities and infrastructure can require a very detailed and extensive discussion. This section of the chapter will discuss the elements and considerations that must be taken into account to meet the desired outcomes.

To understand what information is needed, managers first must understand the data refinement model (Figure 1).

Figure 1. Data Refinement Model
Data refinement is the process by which data become more important to the organization. A facilities department must understand at what level of refinement they must manage different aspects of facilities and the campus infrastructure. Refinement comes in the way data are collected and can be a series of elements or letters. Information comes into existence when the data are organized and labeled so that they become important. Once information is collected and then becomes consistent, organized, or validated, it is transformed into knowledge. Knowledge helps individuals understand what is important and what must be known about a particular subject.

The next step in refinement is wisdom, which comes from understanding the knowledge and then making judgments concerning it. Wisdom becomes information and knowledge-based management when the gathering of information and knowledge can lead to better decision making. In the information age, this process of gaining wisdom from knowledge involves continuous learning, as things continue to change. Better learning takes place from the better knowledge that is available. In the past, experience brought wisdom, but in today's environment, knowledge that is reliable, meaningful, and useful and that can be verified helps build the correct informed judgments that are needed to produce wisdom in the midst of a fast-paced decision-making process. Knowledge and wisdom together help identify true principles that govern various situations and areas. Once knowledge is analyzed and prioritized, the decisions that must be made become clear. It is important to understand the data refinement model and the kinds of data that must be gathered in the management of facilities and campus infrastructures. The refinement process will help to determine the kinds of data, information, and knowledge that are needed for managers to make correct decisions. Experience has suggested that the most important part of gaining good information and knowledge is identifying the correct data elements that are needed within the facilities management profession. Ongoing management of data elements, like management of other resources, is a critical part of the facilities management process. It is important to know from the beginning the real purpose for each data element and the role each element will play in the management process. Managers must be selective regarding the data, information, and knowledge needed to meet the core stewardship roles assigned to each facilities organization.

**What Are the Boundaries for the Kinds of Information Needed?**

In every organization, there must be a boundary within which the kinds of information needed provide focus for the organization and give meaning and value as to what is important. In general, each organization is limited to the kind of stewardship role it is asked to play as part of a higher
education institution. This stewardship role, or mission, and the corresponding level of resources will vary. The boundaries within which all of the organization functions are centered on the core beliefs, vision, and mission of the organization (Figure 2). Once the vision, mission, and core beliefs are understood and agreed on as the major stewardship roles of the organization, then the boundaries that limit the kinds of data, information, and knowledge needed to function within the prescribed organizational structure can be established.

Figure 2. What Guides People to the Information They Need

The core beliefs, vision, and mission should drive the strategy in which the organization functions. Strategy will help to define the environment in which the organization wants to work. Proper direction and the continuous improvement process will help the organization meet its ongoing purpose. Once the strategy has been defined, it should drive the organization's structures and systems. Most of the data, information, and knowledge needed for the organization will come from the way that the structures and systems are established. Structures and systems should focus on people making good judgments, and these judgments should be in line with and provide congruency to the organization's core beliefs, vision, and mission. Each part of the strategy, structures, and systems should clearly define what data, information, and knowledge are needed so that wisdom can be used in making the correct judgments.

All data, information, and knowledge must support this process. Higher education facility professionals must first be clear with regard to their core beliefs, vision, and mission. They should then proceed to make sure that their understanding is driving the strategy, structures, and systems that are in place to provide the desired level of service. The data, information, and knowledge from this process must provide feedback and assurance that people are making good judgments and that those decisions are congruent with the core beliefs, vision, and mission assigned to them. An understanding of the roles played in this process will help focus and provide boundaries to the kinds of data, information, and knowledge needed from the organization's people for the
organization to be successful. It will also give clarity to those involved in the process regarding the kind of information they need to lead and properly manage the role and stewardships they are given.

Systems Interface

Because the facilities organization is part of a university or institutional system, it is important to identify the types of systems and interfaces needed to meet the ongoing requirements of the facilities organization and the institution. In many situations, university systems are already in place and set up to support the various other services and functions that must be carried out by the facilities organization. However, in many cases there are systems unique to facilities management that are not shared. University-wide and departmental structures and systems must be understood by facilities personnel and mutually supportive of one another. A careful review of what is needed by the facilities organization, followed by a clarification as to whether this information is provided by other university systems on campus, is critical to a well-functioning system. Figure 3 shows the kinds of systems that could be shared between a facilities management system and an administrative university system. Each physical facilities organization must decide on the kinds of systems needed for it to be successful and what role the organization must play in other campus systems.

Facility Resources

Generally, each facilities organization is given five types of resources to manage, given the organization's responsibilities and stewardship role. The level of resources varies by institution. In most cases, the level of resources provided by the institution determines the standard to which the facilities will be managed.
Facilities managers are required to maximize those resources and make them as productive as possible. Each facilities manager is challenged to meet a given level of expectation with the given level of resources. In some cases, the resources fall short of the expectations. Therefore, managers must continually identify those needs that will require resources in order to meet the level of expectation. The limited resources provided to facilities managers requires that they use data, information, and knowledge to track the needs, manage the effective use of these resources, and identify what resources are needed to meet needs and expectations.

The five resources generally used by facility managers are as follows:

1. **Humanpower**. Humanpower is the number of hours available to complete the tasks within the organizational mission, or stewardship. These can be identified as full-time or part-time...
hours and are usually charged out at a clearing rate cost. The key information needed regarding humanpower is (1) where the total hours available to a facility organization were spent and (2) if those hours met the primary expectation of the given mission.

2. **Machinery and equipment.** An inventory of equipment and machinery on campus helps to define the scope of work for facility managers. The requirements for resources depend on the level of operation, maintenance, and replacement responsibility. The level of resources varies depending on the role and responsibility given to facilities management. Because most campuses deal with distribution systems and other infrastructure within the total campus environment, these items tend to require a lot of resources both annually and long-term.

3. **Supplies and materials.** These resources consist of the items needed to maintain and operate the existing facilities and infrastructure. The challenge in managing this resource is dealing with ongoing changes and development of new and better supplies and materials. Materials and supplies help most in the day-to-day operation and maintenance of facilities.

4. **Methods and procedures.** One of the major resources an organization has is how well it manages its methods and procedures for doing business. The biggest change in this resource since the 1970s has been the development of information systems and the use of computers. The quality movement and the focus on customers have also caused a revisiting of resources assigned to methods and procedures. This major resource must be managed similarly to other resources so that the way in which facility management professionals conduct their business maximizes this resource. Currently, facility organizations are investing more in this kind of resource.

5. **Money.** Money is a resource that helps to acquire the other four resources that are needed to effectively manage the business functions of a facilities organization. Allocating and tracking this resource, ensuring that it is properly used, and managing the annual process of budgeting and identifying needs become major responsibilities of the facilities organization.

Facilities organizations must learn how to carefully manage all five resources. In years past, many of these resources have been managed by focusing on the money resource. Current information systems must be focused on each one of these resources in order to properly account for the resource's management and to determine how effectively the resource is used, given the organization's stewardship responsibility.

### Roles and Stewardships

Facility organizations are assigned the responsibility of managing campus assets. Within the mission of each facilities organization is a set of stewardship roles that must be completed, given the resources available. Each facilities organization needs to identify specifically what those roles are and who and what resources will be assigned to them. This book defines the kinds of facility management stewardship roles that are common in the profession. It is important for each facilities organization to have a clear understanding of the responsibility associated with each role. That responsibility will define the mission. As the responsibility associated with each role is understood, and as resources to complete the responsibility are identified, then facility organizations can determine what data, information, and/or knowledge are needed to effectively and efficiently manage higher education facilities. Stewardship roles must be carefully defined. Once a role has been determined to be part of the mission, then how that role is completed and who is responsible for it must be determined. To have an effective information system and one that
will meet the needs of the organization, it is important that the stewardship roles within the organization are clearly defined and that those assigned responsibility know what is expected of each stewardship role.

Matching the Roles to the Resources

The information needed to manage facilities and campus infrastructures comes from (1) clearly understanding the stewardship roles of the organization and (2) matching the available resources to those roles. Figure 4 is an illustration of how roles and resources are identified. Once the roles and resources are matched, the organization must evaluate the kinds of data, information, and knowledge that are needed to successfully manage the role of the facilities organization.

![Figure 4. How to Determine What Data, Information, and Knowledge Are Needed to Meet Expectations](image)

In some cases, resources will be estimated because they may have to be earned rather than assigned. In other cases, certain stewardship roles will be assigned resources that are tied to contracts or outsourced responsibilities. Other roles and resources will be assigned as needed. In many cases, certain roles will have to be budgeted on an annual basis and other roles will have to be clarified on a long-term basis. In any case, however, all roles and resources must be identified, and the kinds of data, information, and knowledge needed by the organization to function properly will have to be clarified and understood. This is the major use of information within the facilities management profession.

Summary

One of the critical demands for higher education facility professionals in the future will be to have the right kinds of data, information, and knowledge to manage the facilities and the campus infrastructure in a way that meets the expectations of the institution. Facilities organizations need a clear understanding of their vision, mission, and core values so that proper strategies and uses
can be established. The strategies must provide proper structures and systems to support and give feedback so that they are congruent with the key stewardship roles of the organization. University and facility management systems must be interfaced and must work together so that there is little duplication of effort. The kinds of data, information, and knowledge needed by the institution must be available from either system. It is important that the limited resources given to facility managers are matched to the key stewardship roles. Data, information, and knowledge are needed, especially where expectation is higher than resources. These needs must be clarified and managed as an additional resource need. Facilities professionals will continue to find resource needs as roles change and as the kinds of resources available to them change. The role of data, information, and knowledge is to ensure excellence in facilities and campus infrastructure management.

Determining and Implementing the Kinds of Information, Applications, and Processes That Could Be Computerized

The information in this section is purposely general, as technology and computerization are changing more quickly than books can be printed. As a result, ideas will be presented on a conceptual level, not as factual detail. By the conclusion of this section, readers should have a better concept of how information technology can help them manage their facility's “business” and the resources on which they must rely heavily: people, time, things, space, air, capital investments, and money.

Separating Opportunities from Restrictions

Every institution and facilities organization has its own personality. This will define and dictate political realities and expectations. In addition, the organization's information needs are either formally or informally dictated by its chief administrator, often through his or her style of management. As an extreme example, a “micromanager” will have radically different information needs and will allow subordinates access to different levels of information than a laissez-faire kind of manager. Therefore, the logical first step toward an attempt at computerization is to quantify and qualify the true attitude of the organization's leadership. This is a barometer that must be read carefully and correctly. **There must be a long-term commitment, financially and otherwise, from the very instant a plan is agreed on. All the players must agree to the same plan.**

As this attitudinal reality is evaluated, one must also be sensitive to the campus's or system's official position toward decentralization of computer/information services. Whatever this position is, it will have a long-term impact on the approach selected, or whether an approach is selected at all. If the campus or state system prohibits decentralization, then time will be better spent working on an effective relationship with those who might be doing the work on behalf of the facilities organization, to ensure responsiveness and to minimize costs.

Selecting Opportunities

As indicated earlier, information technology can be effectively used for any aspect of the facilities management business. Among the most obvious ones are the following:

- Key control
- Preventive maintenance
- Work order (job) control
- Payroll (pre-) processing
In addition to those already listed, numerous successful facilities officers have expanded the use of information technology in even more diverse directions, such as the following:

- Centralized campus energy management
- Run-time totalization
- Lock control (cross-references)
- Utility consumption and tracking
- Invoicing
- Motor pool/fleet control
- Vehicle utilization analysis
- Card access and security
- Personnel history files
- Water distribution system control
- Clock correction system
- Sprinkler/irrigation system operation
- Custodial and grounds standards

Zeroing in on Specifics

Information technology allows managers to measure and track the most minute of details. Thus, the issue for facilities professionals is not to identify what can be measured; rather, it is more what can we measure and track that will help us achieve our mission.

Recent literature has explored the ethics of information technology and suggested that electronic data collection and storage has become an ethical issue. Information technology allows individuals to capture any data they want; they then hope to manage it. This is why, before managers develop a ballooning set of data, they must have a clear understanding of what they are going to do with it. Merely storing and occasionally listing volumes of data (either in print or on the screen) may not achieve any goals, at least to a mission-serving extent. It is hoped that managers will be able to extract from it some meaningful information. For example, it may not be particularly meaningful to track the amount of time a storeroom clerk might take to fill each individual order. Instead, it may be useful to identify the number of orders filled or not filled during the course of a day, and how much time is spent by tradespeople who are waiting to be served. Another example might be tracking downtime on clocks across the campus. Each individual clock may not be relevant as a cost center, especially if there are thousands of them to track. However, if all clocks are taken together as a system, then cost and time tracking may be of benefit.

Even information is not the end in itself. It can sit on a shelf, quite literally, without helping managers do the right things right. Managers must be able to take this information and turn it into knowledge, with which they must feel comfortable if they are to make the right decisions. Thus, there is a natural progression from data (facts, details) to information (a useful collection of pertinent facts, organized in some meaningful way), to knowledge (knowing what and where the pertinent information is). The final ingredient, wisdom, has to come from the individual, who should possess the skills to know which decisions to make, when to make them, and how to apply them. Knowledge applied without wisdom may lead to misuse or abuse of power by those who
have access to *information*, in which case there is no use gathering the *data*.

Thus, when evaluating opportunities for computerization, such as the ones listed earlier in this section, the manager must be confident that there will be a progression possible from data to knowledge. To achieve this progression, and therefore to reach the most successful decisions, pertinent team members must feel a sense of participation and ownership. For example, imagine designing a custodial standards program, with its appurtenant data collection and flow, retrieval, and utilization. It makes more sense to have representative custodians, lead workers, and supervisors involved with the information systems professionals than to have the information services manager and the senior custodial administrator area isolate themselves in a conference room to dream up something to which no one can relate. Failure to involve the right people in the process will increase the risk of nonuse of the information, if not (un)intentional sabotage of the data collection process. In other words, a total waste of effort and resources may well result.

When preparing to launch such an effort, a useful beginning may be to develop a vision, no matter how narrow or broad. Having a framework and a purpose established early in the process will help all participants to embrace it and to stay focused on it. Vision, mission, goals, and principles (discussed elsewhere in this manual) are concepts that easily apply to this process as well.

Information/knowledge systems require a great deal of accuracy, both on the front end and on the tail end (i.e., input to output). For some information components, tolerance of the "fudge" factor may be greater than for others. The manager has to be able to determine, verify, and ensure the likelihood of being able to acquire acceptably accurate input. Occasional modification in the process or the device for collection of data may be justified, although care must be exercised when considering this approach. The less the front-liner (e.g., the carpenter or plumber) has to be troubled by a change in process and procedure, the less likely it is that the information system will be subjected to passive interference and sabotage. Acceptably accurate and timely input is mandatory, or else the (sub)system may be doomed owing to a lack of reliability. Simply making printouts and look-up screens look good, and extending numerical data out to more decimal places will not make the data more accurate. Users have to be able to place a consistently high degree of credibility in the output, or information will fall into disuse. Again, much of this points right back to the reliability and accuracy of the initial input. If the information is of no use, then either the wrong data are being collected or the data being collected are wrong. Either way, the data are not worth collecting.

Finally, the manager will want to examine seriously which units and tiers of the organization are most likely to benefit from the successful application of information technology. It is a virtual impossibility to illustrate specific results of this self-analysis. The organization's structure, level of outsourcing, and operational independence and interdependence plus other factors will help identify potential benefactors of information and knowledge disseminated through information technology.

As Figure 5 shows, the complexity of the information to be shared can be accepted on variously successful levels by differently motivated, trained, and skilled staff. The relationship can go from a straight-line function to an exponential function, or anywhere between the two. The Y axis represents hypothetical values assigned to the complexity of a single subset of information. The intent is to emphasize those areas that are most likely to offer beneficial results in terms of utilization and operations impact, even though those areas may not necessarily provide the highest immediate payback. They may help identify success stories on which future development and motivation can be built. They may also help identify areas where additional, specialized training is appropriate for certain groups of users.
Naturally, the ultimate intent for developing a technologically advanced information environment is to serve the success of the organization. This cannot and will not happen without the willing participation and acceptance of the individual players who are responsible for process input and output.

**Conducting a Self-Evaluation**

A careful and objective self-analysis regarding information technology must be performed. Most commonly, managers will want to look at areas or criteria such as the following:

- Impact on existing personnel
- Impact on existing systems
- Impact on existing hardware/software configuration and commitments
- Budget opportunities (short-term and long-term), recognizing the need for continual support of maintenance effort on hardware and software
- Potential cost benefits, avoidance, and payback (short-term and long-term)
- Impact on the organization
- Impact on the campus and/or system
- Impact of selecting off-the-shelf turnkey systems versus developing most or all of the system in-house
- Security (hardware and data, as well as the environment)
- Opportunity to phase into a full system
- Opportunity to integrate the bulk of facilities-related data into an integrated or relational database
- Implications of time or deadline restrictions, implied or overtly expressed
- Implications of life cycle costing and migration possibilities
- Opportunity to establish a fund dedicated to the regular replacement and/or upgrade of the system, software, and components
- Opportunity to provide support from within the organization versus utilizing on- or off-campus consultants
Implementation

Once (or if) an acceptable level of success can be reasonably predicted through the preceding self-analysis, the organization may be ready to take the next step. It may be safely assumed that most organizations have reached some level of computerization. In identifying the direction to which the organization wants to commit for the foreseeable future, decision makers at all levels must consciously decide whether to abandon or sideline all the hardware and software in which they have invested to date, or integrate it into the new system. Experience has often shown that tagging new concepts and processes onto old and partially effective computer programs is not productive and almost never is cost-effective in the long run.

The team established to implement the system does not necessarily have to include the same individuals who made up the initial assessment team(s). This group of individuals must be technologically savvy. In terms of hardware, for example, consensus will have to be reached on whether to choose a stand-alone personal computer, a local area network (LAN), or a minicomputer interconnected with a LAN or linked through a local gateway to a central campus or system computer. Once this decision has been safely reached (after having contacted and worked closely with all the pertinent participants), the decision as to the kind of software becomes somewhat easier. However, some key items still need attention.

For example, it is often easier initially to purchase an off-the-shelf package that can get the process started. The down side of such a decision may be initial high cost, a lack of system flexibility, and/or the need to seriously modify the existing "paper flow" to adapt to the new system. There are many packages available, with new ones being developed all the time, that may work very well in individual applications. The constant to remember while evaluating off-the-shelf software is that it cannot be made to fit—either it fits or it doesn't. Some vendors will not permit modification of their software except at high cost. It may also be necessary to purchase an assortment of packages, each of which will serve different purposes, that cannot share input or data. As a result, duplication of input effort may be inevitable. On the other hand, there are a number of packages available that will do almost anything imaginable in a facilities environment and may fit the organization's needs. The manager must be cautious, however, as the purchase price may include expensive features that may never be used in the plan developed by the implementation team. One significant advantage realized by purchasing software and hardware from the same vendor is that there is less risk of annoying "finger pointing" when something goes wrong than there is when software is custom developed.

Developing one's own software system certainly also has its advantages and disadvantages as well. One obvious advantage is that the design can be custom fit to suit the organization's priorities and expectations. The project can be more easily phased, development and training can progress in a well-thought-out and personalized manner, and hardware can be acquired and the configuration expanded as work progresses. Immediate results will often be more difficult to detect. The cost (design, development, and maintenance) can be high, depending on whether an in-house programmer can be employed or the organization has to pay a consultant. Another disadvantage is that an individual programmer often will have his or her own methodology and idiosyncrasies,
leaving unique "fingerprints" on the system. If that person ever becomes unavailable, the organization and its system could be left stranded.

Individual organizational circumstances may justify a carefully selected mix of purchased and custom-made software. In any case, one can plan on the development and maintenance costs of the software far exceeding the total cost (including first cost and hardware/software maintenance contracts) over the life of the information system. Daily costs of input and control will have to be considered, in addition to any of the costs described above. The manager can be assured that the total actual cost of implementing and maintaining a system is much higher than originally projected.

Measuring (Detecting) Progress

The implementation team, with full support from all levels of the organization (including the final users), must identify expectations, deadlines, and benchmarks. These must pertain to both the development of the system and the system's actual performance once it, or phases of it, get online. If there is a contractual relationship with a third-party vendor (even if that should be a campus or system department), strict performance criteria must be identified and agreed on. Remedies must be preidentified for results that do not quite match expectations. The following questions and issues must be anticipated:

- What steps must be taken to come back on track, if that is even possible?
- If it is not possible, what steps must be taken (and by whom) to ensure achievement of the intended long-range goal and vision?
- Who has to cover the increase of cost?
- If the new system is to replace an existing one, how is the continued expense of the existing system going to be handled?
- If there is a loss of revenue or income because of the delays, where does the liability reside most logically?
- What kind of resources beyond financial (e.g., space and staff) must the facilities organization provide during the design and programming of the system, and who will have to carry the burden if the original completion date cannot be met?

Employees who have had the benefit of being involved in the development of the entire project have certain expectations, as well as the right to stay in touch. They do not deserve to be kept in the dark about the successes or disappointments of the project. Here, as in other situations, the "grapevine" is destructive. High enthusiasm can rapidly deteriorate to disillusionment so that even when the project is finally completed, the spirit is no longer there. For this reason, among others, the organization's leaders must remain actively and visibly involved with the project throughout its completion and implementation.

Impact of the Information Revolution (Technology) on Business Functions in the Future

Digital technology is going to be the preferred format for dealing with information in the future. Alan G. Merten, Dean of Cornell University's Johnson Graduate School of Management, has stated, "It's not emerging but merging technologies that are important to understand." In the management of educational facilities, effort must be made by each facilities professional to ensure that proper data, information, and knowledge are gathered so that the correct decisions can be made. In the past, experience has been a major factor in making correct decisions. In the current fast-paced, changing environment, and with the infusion of technology in almost all aspects of business, the need to gather the right kinds of data, information, and technology is essential.
As stated by Merten, the challenge that all managers face in this new environment is understanding how the merging of technology affects the way in which the business functions of the future will be handled. The merging of technologies creates a new kind of problem for business. In the old paradigm, many pieces of data and information were handled according to responsibility and by set groups; these data or information were combined using the balance sheet, the project report, the work order, or other kinds of formats where summary information became important to the management decision. With today's technology and the merging of many different ways of doing things, a summary of many different pieces of information can be made available to the decision maker on an as-needed basis, without the customary waiting period required with the old paradigm.

Two of the main factors currently affecting higher education facilities professionals are awareness and availability. The awareness issue in technology concerns how to cope with the ever-changing way in which information can be made available to the decision maker. It is a massive problem involving focusing on what is changing and the timeliness with which that information can be used to make proper decisions. Many have stated that dealing with awareness will always begin in the school systems and will eventually update the work environment. However, the speed with which awareness can be converted to data, information, knowledge, and decision making has created a competitive edge for some work environments. Higher education facility professionals must know (1) how technology and information can be translated into the work environment and (2) how to train staff and individuals to provide this kind of information and input so that proper decision making can be made. Awareness can be defined as an important factor in the information revolution. The experience of yesterday is being replaced by the ability of facilities organizations to learn and understand what is important and how this technology can be used in making decisions.

The second key issue is availability. Technology is an investment, with its important payback being the availability of information that is important to making good decisions within the facilities organization. Technology is a long-term investment in terms of how an organization functions with technology, but it has a short life cycle in terms of its useful life. Therefore, the availability of technology, its purpose, and a justification in terms of its value to the organization become key issues. The facilities management profession must continue to make technology available to the work environment. Managers can benefit from technology even if the learning curve seems impossible. An awareness of how technology can benefit facilities work and a long-term commitment to making available the tools required for that technology are the two key factors that will continue to change the business of the facilities management profession. Facilities professionals must be wise, considering technology a tool to help them make the best decisions. The error factors in today's fast-paced environment require an investment in good information.

Keys to the Future

There are ten critical technologies that will help guide managers to tomorrow's information systems. These technologies are broad enough that their current specific status is not as important as the combined effect of all of them. The ten technologies are semiconductors, optoelectronics, parallel processing, storage, object programming, agents and artificial life, speech recognition, wireless communications, ATM switches, and compression; these can be divided into three groups: hardware, software, and communications.

Hardware

The focus of hardware in the future will be in the following four areas: semiconductors, optoelectronics, parallel processing, and storage.
Since the 1970s the information revolution has been built on silicon-based chips (i.e., more circuits in the memory of a microprocessing chip). Engineers have made computing technology less expensive, more plentiful, and more adaptable to new uses. Without these improvements, the spread of information technology would slow, and new applications would be beyond our grasp. Scientists initially had doubts that silicon-based improvements would continue in the future; they feared that by the year 2000, they would run up against physical barriers. However, this "science limit" has been lifted by new research, and scientists have determined that there is no limit through the year 2030 in the use, speed, and size of hardware components to meet the needs of the users. Exponential growth in processing speed and storage ability is expected to continue. For the foreseeable future at least, it seems that silicon will be able to match the needs of increasing demand in the marketplace. Applying the latest chipmaking technology to processors will yield chips as powerful as the supercomputer of today with the cost of the chip being a few hundred dollars. Thus, whatever the task dreamed up for tomorrow's computers, silicon has the horsepower for it.

Optoelectronics

Sometimes referred to as the invisible backbone of the information age, optoelectronics is the marriage of light and electricity. Without this underlying technology, there would not be an information infrastructure. Currently, fiber optics is making the biggest difference in telecommunications. Researchers continue to "push the optoelectronic envelope." Scientists may create devices with unheard-of storage capacity. Scientists currently predict that they will be able to pack perhaps 18 trillion bits of data on a single 12-inch platter. This could mean an explosion of low-cost, high-speed communications capacity and the ability to store floods of digitized video and sound on key components of the information superhighway. Breakthroughs in manufacturing will be the key for the future.

Parallel Processing

The idea of parallel processing can be described in this example: You and ten friends can paint your house a lot faster than you can paint it by yourself. This logic of teaming up to compress the time it takes to get a job done is the basic idea behind parallel processing. This is the key technology for the future. The merging of current technologies and the addition of new technologies are putting undreamed-of demands on computing hardware. Parallel processing is needed to make multimedia and information superhighways work at speeds acceptable to users. The trouble is coordinating those various processors and making sure that the right processor gets the right piece of information at the right time. It is predicted that all processing in the future will incorporate a form of parallel processing. Currently parallel computing is limited to larger computer hardware, but eventually, it will move to desktop computers.

Storage

The question for storage is: "Can conventional and disk drives keep up with the demands of the information superhighway?" Most say the answer is "yes" if routine technology improvements stay on track. The key to the future will be a more precise positioning mechanism that will allow heads to fly closer to the surface to read denser data. CD-ROM improvements will assist greatly in meeting future needs and will provide an even bigger boost to what information you can get from the storage units. IBM Vice President Christopher Bajorek has stated, "We are probably decades
away from many functional obstacles that would inhibit the progress of these technologies.”

Software

The software technologies that will most affect business functions are in three areas: object programming, agents and artificial life, and speech recognition.

Object Programming

Object programs in the future will (1) make program writing faster and software more reliable by using prefabricated building blocks, (2) let different applications share common functions, (3) mix and match objects to customize, and (4) break down barriers between different applications and types of computers. The overall key to object programming is quick learning and practical application, as well as objects that promise to eliminate the need to shift from one program to another when the user wants to switch tasks. As things get more complex, object programming will help simplify learning and cause learners to excel. This must happen for technology to be a trusted tool for the user.

Agents and Artificial Life

What is life? Scientists and philosophers have tried to answer this question. Living things grow, reproduce, and finally die, and researchers in the field of artificial life are creating entities that are doing likewise. Programmers are creating artificial organisms from the "primordial soup" of digital bits. This intelligence floats invisibly across the computer networks, feeding on data, meeting, growing, learning, involving, and even dying when its utility has passed. The fruits of artificial life will be as follows:

- Sophomore "agents" may be able to act autonomously to learn how to solve problems.
- Software code may automatically evolve using a "genetic algorithm."
- Complex computer simulations will predict environmental, social, and biological trends.
- Robots programmed to mimic the simple reasoning of insects may "learn" to find their way.

Many believe that trying to put reason into data and information is a possibility and may be a need owing to the information and knowledge growth that has taken place around the world. Something must be able to understand new and different information so that it can determine what information would be of most benefit in certain situations.

Speech Recognition

Currently software helps computers recognize any person's voice, but "speaker independence" is limited to a vocabulary. Computers can understand some coding, but this is usually limited to single words (e.g., yes or no). Increased memory and faster processing will allow computers to handle more variables. "Print chart cuts" are used to restrict the vocabulary according to a topic. At the current rate of progress, researchers say it will be about a decade before speech recognition replaces the keyboard for most uses. George R. Doddington has said, "The only way that is going to happen is for computers to learn to understand what people say.” 5 He went on to comment that the understanding of how to do it is there, but technology and capacity are needed to get to the point where this understanding can be applied.

Communications
The information revolution that will most affect business functions will probably be in the area of communications. The three areas that seem to promise the most change in the future are wireless communications, ATM switches, and compression.

**Wireless Communications**

Wireless communication is high-quality voice and data service, anytime, anywhere. Advancements in technology promise to make wireless communication networks as capacious and reliable as fiber optic lines. It will take several years for any of the new networks to challenge the current cellular networks. Currently cellular companies are beefing up the ability of their networks to handle data so that customers with wireless modems and notebook computers can receive and mail messages. An understanding of how wireless communication might be accomplished does not yet exist, but many believe that wireless communication certainly must be a primary goal of communication advancement.

**ATM Switches**

Many have a high expectation for being able to use digital formats for movies, stock quotes, electronic shopping, and many other things, all with the same technology. The asynchronous transfer mode (ATM) is the key to meeting the needs of all of these merging technologies. "ATM's ability to funnel billions of bits to where they are needed will make the network to end all networks," says Paul D. Callahan of Forrester Research, Inc. ATM's trick is that it divides information into tidy packages or cells of 53 bytes each. The cells are coded or stamped with an address and then zipped over the network at high speeds. The switch at the other end decodes and reassembles. The big problem of getting to an ATM environment is the lack of fully standardized equipment in software. One of the holdbacks now is price, which seems to be coming down as technology develops. ATM switches will certainly be the major merging technology support for the future.

**Compression**

Finding a place to "park" digital information when it is not in use has been a problem as the use of information has increased. Compression is the science of squeezing large amounts of digital data into less space. Experts say that the progress of compression may be slowing down. "We have already thrown away 99 percent of the video signal in storing video," says John Forest, Chief Executive of National Trends Communication, Ltd. Researchers suspect that the next level may deal with a web of thousands of tiny microcomputers that will have the capacity of larger compression systems. Many say this is years away. This must happen, however, or traffic on the information superhighway could be stalled.

**How the Information Age Is Changing Business**

The advance of digital technology is having a dramatic impact on businesses, workers, suppliers, and customers, and on how business is accomplished. As paraphrased from Ira Sager's article, the following five areas of change not only are common to the world around us, but also have a major impact on the way higher education facilities are managed:

1. **Organization.** New electronic systems are breaking down old corporate barriers, allowing critical information to be shared instantly across functional departments. Information for all stakeholders is available and accessible.
2. **Operations.** Manufacturers and service organizations are using information technology to
shrink cycle times, reduce deficits, cut waste, and provide better communication. Likewise, service firms are using electronic data interchange to streamline ordering and communications with suppliers, customers, and leadership.

3. Staffing. New systems and processes have eliminated management layers and cut employment levels. Meanwhile, companies are using less costly computers and communication devices to create "virtual offices" for workers and far-flung locations.

4. New products. The information "feedback loop" is collapsing development cycles. Companies are electronically feeding customer and market comments to produce development teams so that they can rejuvenate product lines and target specific customers.

5. Customer relations. This is no longer simply an "order entry" job. Customer service representatives are tapping into company-wide data bases to solve callers' demands instantly, from simple changes of address to billing adjustments.

Even though these five issues focus more on the change of business around us, they also affect the ways in which facility management is dealing with its stakeholders and issues of business. Efforts are being made throughout institutions to network and supply quicker, better, and more focused information with pure resources and quality results. Information technology and the information age itself are becoming great equalizers among businesses. In the higher education facilities profession, it will allow for more competition or outsourcing—not necessarily in the responsibilities, but in the way in which the responsibilities are carried out. The real threat for current facilities professionals lies in not changing and taking advantage of technology. Thomas H. Davenport, Jr., a consultant with Ernst & Young, has stated, "Sharing information becomes really critical to any organization's success", "The problem", Davenport argued, "is that many companies spend big money on technology to allow employees to share information, but forget that sharing ideas is an unnatural act in corporate cultures that reward individual achievement. If we really cared about information sharing, we would start to evaluate people on how well they share." The next revolution may occur in information sharing rather than just information technology. Determining and implementing information applications and processes that can be computerized will help answer this question. It is important for the higher education facilities professional to use technology as a tool for dealing with professional issues. It will be important for those in the profession to understand the impact of the information revolution on business functions and how technology can streamline business and affect the future.

Summary

The foregoing ten areas of technology will have a major impact on the way in which business is done. Business functions in the future will continue to merge and change the way business is carried out. These critical technologies are the keys to the future. Nothing is final, but better "mousetraps" come along all the time—not in one neat package, but bit by bit. Higher education facility professionals must identify the needs and expectations of the institution and then find ways in which technology can help provide the key information needed to be successful.

The Internet and the APPANet

An abundance of literature is available about the Internet, its countless uses, and its abuses. APPANet is one of the many players on the Internet, which is growing exponentially. This service, offered through APPA: The Association of Higher Education Facilities Officers, links the member and nonmember (to differing degrees) to the products and services offered by this association and others. Because APPA sees its vision primarily as one of supporting its members in being "global partners in learning," these products and services are designed to lend themselves to that
purpose. The methodology of accessing APPANet will change continually and rapidly in the very near future. Individual members must stay current on the best and most relevant method for access. This method must be relevant to the member's situation on the campus, and it must be consistent with the information technology configuration present in the member's organizational environment.

APPA and peer higher education associations seek to provide, through the use of "hot links" or "hypertext," a total information resource to individuals working in and on behalf of higher education. Through the use of links among the numerous databases maintained by different associations and organizations (including an increasing number of participating individual campuses), individuals with access to the Internet (and therefore to APPANet) will have at their fingertips a plethora of knowledge that can help them individually achieve their professional and personal goals. It is immaterial whether the member works at a small institution or a huge research university. The distinctions will vanish through this opportunity of access and sharing. The information shared through this process will explore all imaginable aspects of the higher education environment, taking facilities managers and officers out of the pure "brick-and-mortar" environment and into the continuous learning arena. For facilities professionals (as with society in general), learning cannot stop at graduation. APPANet is designed to help provide another information conduit to encourage anyone who is so motivated to stay ahead of trends, needs, and expectations in higher education.

Notes


